

## Beautiful Questions

*Good questions lead to focused goals for Ames Lab undergraduate*

*“Every man ought to be inquisitive through every hour of his great adventure down to the day when he shall no longer cast a shadow in the sun. For if he dies without a question in his heart, what excuse is there for his continuance?”*

Frank Moore Colby  
*The Colby Essays* [1926]. Vol. I

**W**e can forgive Frank Moore Colby for not being politically correct with gender usage when he wrote the above quote in 1926. It was a different era, but the message his words convey applies to all people for all time.

Sanja Pudar knows this. Pudar grew up in Serbia, and immigrated to the United States in 1999. She and her family settled in West Des Moines, where she finished her remaining year in high school at Valley High.

Pudar entered Iowa State in 2000, declaring a major in chemistry. As luck would have it, she ended up in a section of introductory chemistry for chemistry majors that was taught by Mark Gordon, Applied Mathematics and Computational Sciences program director and an ISU distinguished professor.

“That was one of the best classes of freshmen I’ve taught,” recalls Gordon. “I measure how good a class is by how many questions the students ask, and Sanja asked the most and best questions by far. If she didn’t get an absolutely complete answer, more questions were sure to come,” he adds with a smile.

“Professor Gordon is very knowledgeable. He speaks slowly and at your level,” says Pudar. “When he explains something, I’m always able to understand.” Gordon’s enviable knack for clarifying difficult concepts is why Pudar returned to him with her chemistry questions time and time again, even after he was no longer her

instructor. Gordon says he was impressed by Pudar’s drive and competitive nature, so on one of her return visits to ask some questions about electrons, he offered her the opportunity to work as an undergraduate research assistant in his chemistry group.

“I didn’t know how to respond to his offer because the work he was doing was beyond me,” says Pudar, who was a second semester freshman at the time. “I didn’t think undergraduates were doing research in his group.” After discussing the offer with her parents and asking Gordon some more questions about what she’d be doing, Pudar decided to accept the undergraduate research assistantship. Around that same time, she received an internship with ISU’s Women in Science and Engineering Program, so Gordon became her mentor for that program, as well.

Although she had the motivation, Pudar knew she didn’t yet have the academic background to pursue the research in Gordon’s group. She needed knowledge of quantum chemistry, a course typically reserved for juniors and seniors. Her lack of training in quantum chemistry didn’t discourage Gordon. He had confidence in Pudar’s talent and recognizing her potential, he tutored her for several weeks until she had learned the necessary material.

“Tutoring Sanja was different from tutoring anyone else,” says Gordon. “I don’t think anyone has ever pushed me as much to get into the details.” Noting that he typically skips over some of the more detailed math in his intense tutorials on quantum mechanics, Gordon says Sanja wouldn’t allow it;

she wanted to understand everything. “I’d tell her it was pretty complex, and she’d say, ‘Let me be the judge of that.’”

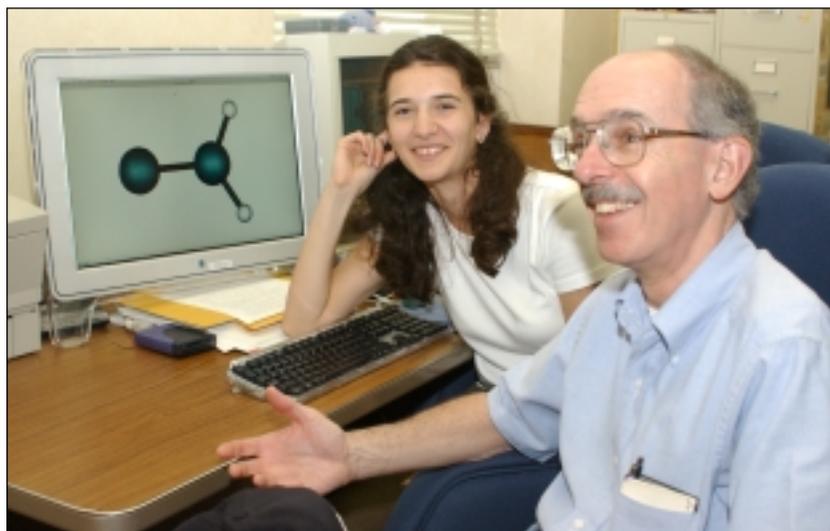
Pudar succeeded in mastering the material, details included, and was rewarded with her own research project, which is sponsored by the U.S. Air Force. “The research involves investigating high-energy materials that may be used to develop a more efficient rocket fuel for space-ships,” says Pudar with obvious enthusiasm. Her project focuses on propellants consisting of solid hydrogen doped with light metals plus liquid oxygen as an oxidizer. More effective propellants might be obtained by oxidizing a boron or aluminum-doped hydrogen matrix because these metals react so exothermically with oxygen. To determine how favorable a reaction is, Pudar studies the intermediates formed during the reaction of boron and hydrogen molecules.

Pudar’s project is a tough one that challenges her, but she likes it that way. “I’m one of those people who likes to develop their intellectual abilities,” she says. Working with Gordon and his chemistry group has definitely

given her that opportunity, as well as invaluable research experience. Just completing her second year at ISU, she’s already attended one professional chemistry conference and is looking forward to another one in July where she will present her research in a poster session. “Working with Professor Gordon has helped me focus my goals and given me a clear vision of what interests me,” Pudar says. “I plan to attend graduate school to study quantum chemistry and become a theoretical chemist. I definitely want to be both a teacher and a researcher.”

Pudar says many students her age might question why she chooses to spend the summer doing research and, as she puts it, “taxing my brain.” It’s a question she never asks herself. For her, there is no choice. “I don’t want to waste my summer on things that are not related to my future,” she says. “Working with Professor Gordon gives me a great chance to double my abilities and increase my knowledge, and I’m surrounded by great people here!” ■

~ Saren Johnston



**Sanja Pudar has her own research project in Mark Gordon’s chemistry group, an assignment she earned by learning the necessary quantum chemistry during several weeks of intensive tutoring sessions with Gordon. On the computer screen is a model of  $H_2BB$ , the boron hydride molecule she studies in her work to investigate more efficient, high-energy rocket fuels.**